

Efficiency optimization of the transportation supply chain activity: the maritime option for Volkswagen Autoeuropa

Abstract

With the current pressures for companies to reduce their CO2 emissions levels and the worldwide competition more fierce than ever it becomes critical for companies to optimize their processes and improve supply chain efficiency. Develop solutions that could satisfy both these requirements is mandatory to improve and sustain today's businesses. For Portuguese industries with high transportation costs the maritime option has become increasingly reliable, experiencing a huge structural and technological improvement in the past decades.

This work project aims the study of maritime transportation feasibility for Volkswagen Autoeuropa company; it combines the strong theoretical background with a data analysis and multi-scenario assessment.

The methodologies used were the billing analysis, at the beginning, then followed by a thorough analysis of transportation and inventory costs and volumes which led to a range of potential supplies to be transported by maritime. At the end the result was 3 possible routes which demonstrate after the analysis only one be a viable option. It was performed also a CO2 analysis, a risk analysis and consequent contingency plan in order to finalize a complete approach to this maritime project.

Keywords: automotive sector; Volkswagen Autoeuropa; maritime transport; inbound transportation; inventory management.

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Confidentiality Disclaimer

Considering the confidentiality agreement assigned to this work project, in full alignment with Volkswagen Autoeuropa, all numerical data of Volkswagen Autoeuropa present in all sections of the work project, namely data analysis are merely indicative values.

Besides that, for confidentiality reasons, the names of Volkswagen Autoeuropa suppliers are not mentioned and maritime carrier name is fictitious to protect real identity.

All persons and entities that read or consult this work project thesis are obliged to maintain confidentiality.

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Index:

1. Literature Review	1
2. General Methodology	1
3. General industry analysis	
A. Business Environment	
• Characterization of Automotive Sector	2
• Key Drivers of Automotive industry	2
• Evolution of the Sector –market trends and future Opportunities	3
B. Competitors Analysis	4
4. Business Description	
• Value Proposition - Assess the Competitive Advantage of the company	5
• Volkswagen Autoeuropa Vision	6
• Volkswagen Autoeuropa Mission.....	6
• Strategy of VW Autoeuropa	6
• Value Chain and Supply chain	6
• Industry Mapping	7
5. Internal Analysis	
A. Autoeuropa VW Logistic department characterization	7
B. Major problem Analysis and Discussion	8
C. The relevance of a Maritime Option	8
• Reasons to develop and invest in the new maritime opportunity	8
D. General analysis of transportation actual situation at VW Autoeuropa	11
6. Operation Plan	
A. Analysis Methodology	11
• Current situation analysis - Criteria to analyze the Eastern Europe zone	11
• The first approach was the Billing Analysis	12
• The constrain factors to exclude supplier or even countries from the analysis	12
• Effective analysis of costs and volumes for the selected suppliers resulted from the analysis of constraint factors applied to the billing analysis	13
• The Maritime Option	14
B. The new maritime transportation option	16
C. The maritime routes - explanation of routes step-by-step	16
D. Routes analysis - current situation (transportation and inventories costs)	18
E. Maritime option costs	19
7. Final Analysis – compare maritime options with the current situation	
• Transportation Costs	20
• Inventory impacts	20
• Comparative Route Savings – Trade-offs	21
• Environmental analysis - benefits (CO ₂ savings)	22
8. Risk Analysis	23
9. Contingency Plan: It is important develop an effective and efficient Contingency Plan	24
10. Implementation of Operations Plan	24
11. Conclusions and Finals Recommendations: After the complete analysis performed	24
12. Bibliographic References	26

1. Literature Review

The real effectiveness of an organization is determined by the degree to which it achieves its goals. The effective organization is both efficient¹ (criteria of internal performance) and able to modify its goals as external circumstances change. (Karatas, Güldem, 2013).

The supply chain consists in the activities related to purchase of materials, logistics and supply of materials (in-bound logistics), distribution (out-bound logistics) and inverse logistics (Sarkis, 1999). Logistics has become an essential factor of competitive advantage, a critical competence and perhaps even another first mover advantage, (Handfield & Nichols, 1999; Gibson, 2005; Ghobadian, 2009). To achieve a better logistics performance is traditionally and easier through cost reduction however a more radical approach consist in redesign the logistics system (Christopher, 1992). Well-managed logistics operations pursue the objectives: reduce process inefficiencies, increase the transparency between organizations enhancing the cooperation among supply chain agents, reduce the length of order cycle and improve synchronization in all activities of value chain (Carvalho, 2010).

Transport as well as materials handling constitute the most visible logistics costs, contrariwise inventory costs are the most difficult to estimate and often underestimated (Victoria, 2009). The concept of the transportation and inventory trade-off was recognized formally by mid-1880s (Christopher, 1992). There are also macro influencer factors in the good's mobility industry as: energetic market; exponential growth of emergent economies; severe climatic alterations; development of new policies in the transaction market; politic instability; and intensifications of the natural resources exploration (Arantes, 2005).

The growth of global economies over the last few years has resulted in an incredible demand increase for maritime shipping, resulting in the intensification of port and maritime shipping company's competition (Lorange, 2009). The Shipping industry has experienced extraordinary changes over the last years: maritime carriers form alliances to reduce the transportation costs by sharing costs and risks; ports improve the quality of the traditional port services, implement differentiation strategies by providing more specialized, value-added services and delivering door-to-door transport solutions (Karatas, Güldem, 2013).

2. General Methodology

The structures of this work project starts by understanding of the automotive and maritime industries and then know the Autoeuropa VW company and its activities regarding the supply chain namely the transportation activity. The data analysis starts by the billing analysis for perceive the current situation of inbound transportation, and from this initial analysis is defined a potential suppliers group for implement the maritime transport. In order to calculate the most accurate values an effective analysis is performed to this suppliers group. After that, the

¹The organization' efficiency is measured by the amount of resources used to produce a unit of output (Karatas,2006)

maritime option starts to be explored: the seaports available, the several options of transport inside the ship... and therefore 3 possible routes are created and studied step-by-step. Finally all routes are analyzed at transportation and inventory costs level and a conclusion is reached regarding the implementation of the maritime transportation in VW Autoeuropa company.

3. General industry analysis:

A. Business Environment

- **Characterization of Automotive Sector**

The automotive industry consists in all vehicle production' companies that are involved in the design, development, manufacture, marketing, and selling motor vehicles. Is an industry characterized by a very stable and complex production system; manufactures have to effective control the production processes to succeed in this highly competitive sector. This industry has high barriers to entry including: high costs, economies of scale, brand loyalty and perception of value. The main key to invest in this type of industries is: investment is likely be done in contra-cycle and waves of mass investment are inevitably for manage well its capacity (Achi, 1996). The production system typically in European automotive industry is a mix of traditional mass production features and the Lean concept that has evolved to incorporate standard approaches, such as: zero inventories approach, Just-in-Time and Just-in-Sequence deliveries.² The major types of uncertainty are due to: **Inputs uncertainty** that occurs in external suppliers and demand, **Process uncertainty** that occurs in internal demand and supplies and **Demand and Supply uncertainty** that include forecast errors, change in orders placed by customers and durations of the process lead times (Golinska, Fertsch, Pawlewski, 2011).

- **Key Drivers of Automotive industry**³

The key drivers in the Automotive sector are: **Trade Policies:** lower trade barriers have contributed to increase international competition; **Technology:** plays an important role to create sources of competitive advantages (is an important part of firm's strategy), are vital for coordination at highest precision necessary given the increasing complexity of production process; **Economy:** automotive companies are strongly conditioned by the state of global economy and are often major contributors to local economies; **Legislation:** national and international regulations have increase, automotive industry is being increasingly brought under bureaucratic control. **Environmental:** increase of environmental regulations (more restricted Certified emission standards), social trend in demand of environmentally friendly and alternative fuel vehicles, adoption of more clean energy sources and increase awareness of the scarcity in oil global supply (Rossen, 2011). These drivers had changed along the years.

²Illustrated by study cases: BMW Group's Mini Production Triangle and TPS or Toyota Production System (Harvard Business Review)

³Consult Annex 3:Key Markets and Key Success Factors in Automotive industry

• **Evolution of the Sector –market trends and future Opportunities**

The automotive sector evolution is characterized by continuous change and by being the pioneer in the development of innovative logistics practices. In the early 20th century, Henry Ford's automobile mass production system was characterized by high bureaucratic control, incapable of permanent innovation (Thompson, McHugh, 1996). Since mid-20th century the concept of logistics arises as senior management concern. The energy concerns stand out as consequences of industrialism and oil crises and the major logistics tasks (planning, transport, distribution, warehousing), represented about 30% of business costs. As result of all this, logistics changes occurred: creation of Just-In-Time philosophy, Total Quality Management and Continuous Improvement approaches, more efficient and cost-effective approaches (Kenney, Florida, 1993). Companies restructure their production facilities on a global basis: some manufactures centralized production to gain economies of scale, others set up production facilities in countries that ensure them political acceptability, others have deployed manufacturing processes by partnering with suppliers, through vertical integration, and others through collaborative specialized manufacturing sites e.g. Mini Production Triangle (Christopher, 1992). As consequence of the increased demand for more economic cars, the Japanese car' producers penetrate the global markets (small size vehicles, competitive prices, and low fuel consumption) and quickly established themselves as a major world car' producers, contributing with new practices like Lean approach (Piore, Sabel, 1984). The use of internet opened a range of new possibilities in supply chain processes: facilitated the access to information, eased the way of communicates, helped the adoption of better and faster solutions consequently increasing competitiveness (Morgan, Paton, 1992). The globalization and the expansion of E.U, the growth liberalization of markets and the geographic physical distances no longer being barriers, new opportunities arise for businesses internationalization of big automotive manufacturing companies. Become fundamental for organizations to change administratively, decrease bureaucracy and increase flexibility. The concepts of Integrated Logistics and Enterprise Resource Planning Systems appear, improving the efficiency of the overall logistics chain through the integration of several logistics processes (Machado, 2006). More recently the industry trends are: adopt green technology and eco-innovation (low energy consumption, suitable recycling and less toxic metals), in response to climate change and scarcity of natural resources (Rossen, 2013). As consequence manufactures currently offer alternatives to fueled vehicles like: gaseous fuel, bio fuels, and hybrid vehicles, with low ecological impact. There is also a remarkable evolution in the technology contained in modern vehicles. Another market trend is the production of vehicles designed and manufactured in such way to allow the innovation, the modular design and the reuse, recycling and recovery by

costumers. It is predicted that the world's top vehicle producers and top vehicle-producing countries will shift in future. Forecasts indicate that Volkswagen will displace Toyota as the world's largest auto producer in 2016.⁴ It is expected that auto makers will collaborate more than ever in R&D (Winter, 2013).

B. Competitors Analysis

It's important to understand the competitive arena; through benchmark analysis it's possible to evaluate the performance of competition, identify the best practices in the sector and the key factors that contribute for success. The major competitors of VW are: BMW Group, Hyundai Motors, Nissan Group, Toyota Company and General Motors (GM) competing either through differentiation, focusing on innovation and quality, and through cost efficiency focusing on operations, and logistic transportation.

The GM early decided to implemented new strategies to reduce logistic costs. Currently it uses the strategy of consolidate the suppliers load before they arrive the production plant. Its efficiency in transportation costs is achieved through large shipments (utilize the EOQ Model⁵ to resolve the trade-off between transportation and inventory costs founding the optimal shipping size). It also developed a tool called TRANSPART to evaluate the impact on corporate costs of different shipping strategies, which later become a decision support system, adopted by more than 40 GM plants (Christopher, 1992). BMW was one of the precursors in the field of logistics. In 1993 introduced a new material-planning system developed entirely by BMW which consequent result in stock reduction, higher flexibility and handling costs reduction. Currently BMW, as well as, Nissan and Toyota started adopting new practices in their transportation strategies, changing from truck to rail or maritime transport due to cost efficiency and environmental concerns. Consequently BMW and Toyota have invested in a continuous renew of their fleets, too. BMW, Nissan and Toyota are putting more effort in transport optimization in order to reduce inefficiencies (reducing the number of journeys, optimization of parts' packages design) and ultimately saving costs. They invest also in developing sustainable and efficient intermodal transport strategies and develop route and scheduling optimization to decrease the number of journeys.⁶ By discussing the several tools and models applied to logistics and inventory management managed by competitors, there is an opportunity to further analysis and comparison with Autoeuropa VW systems.

⁴News of Wardsauto: <http://wardsauto.com/plants-amp-production/future-auto-industry-have-fewer-platforms-new-growth-markets>

⁵The EOQ model is the order quantity that minimizes total inventory costs and ordering costs (like transportation costs). It is one of the oldest classical production scheduling models. See in Annex 13 Inventory analysis the complete explanation of the model.

⁶Reference: Patricia Ferreira, "*Gestão ambiental da cadeia de fornecimento: desenvolvimento de um modelo colaborativo para o sector automóvel*"; 2011 http://run.unl.pt/bitstream/10362/5823/1/Ferreira_2011.pdf

4. Business Description

Volkswagen is one of the best and biggest automotive world producers⁷ with headquarters in Germany. The origin of the company dates back 28 May 1937 and was founded by Ferdinand Porsche. Since 1991 in Palmela' region, Portugal, VW Autoeuropa⁸ (initiated its effective production in 1995), represents until today the biggest industrial foreign investment in Portugal with an enormous impact in the Portuguese economy especially at exports level.⁹

• Value Proposition - Assess the Competitive Advantage of the company

Regarding the automotive business the value proposition is focused on defining and managing the most adequate mix of car's key attributes in alignment with customer needs: safety, comfort, reliability and economic. VW Autoeuropa produces the car models: VW Eos, Scirocco, Sharan and Seat Alhambra; exclusives, high quality and premium sport or vans models which are produced, following a rigorous, high quality policy¹⁰ and a total respect by the European Standards regarding work safety and environment protection. The importance of logistics (supply chain) for creation of competitive advantage can be achieved through lowering the unit cost of doing business, or reach differentiation in market place. A company can also differentiate itself in four competitive priorities: quality, costs, flexibility or reliability. VW Autoeuropa¹¹ follows a product differentiation strategy where the cost minimization is not the primary goal but however a concern. The logistics system acts by: ensure a continuity of supply, keep adequate safety stocks to prevent stockouts and at the same time minimize the level of investment in inventories, and be flexible to handle small orders and inconstant frequencies (Christopher, 1992). The supply chain optimization involves: contract qualified services for a low cost, achieve a balance between short deliver dates and avoid stock ruptures, a correct planning and control of stocks and the optimization of transports. These aims to reduce costs and time spent in order to gain competitiveness. With the lean manufacturing adoption, quality and transportation requirement became tighter (given the stock' levels reduced to the minimum). The valorization of experimentation initiatives must be praised and not lead to punishment if they do not work (VW Autoeuropa develop programs to promote innovations and new improvements from employees) and "think outside the box"¹² to lead further to innovations and improvements. Despite this, logistics system cannot do everything well, trade-off are inevitable; therefore logistics system must do particularly well the area that fit better to the company's competitive advantage. Concluding the supply chain management is

⁷Based on VRIO analysis and the Top Ranking Car Manufacturers: Consult Annex 4: VW Group presentation

⁸Consult Annex 5: VW Autoeuropa information

⁹See a news about it in http://rr.sapo.pt/informacao_detalhe.aspx?fid=24&did=91744

¹⁰Consult Annex 5: VW Quality Policy

¹¹Consult Annex 6: VRIO Analysis

¹²Innovation, Organization Culture model by VW employees' involvement in the end-to-end manufacturing and logistics processes.

a key area to achieving competitive advantages and for Autoeuropa these is verified by being the most productive plant, in VW's own criteria, than any other Germany factory.

- **Volkswagen Autoeuropa Vision:** VW Autoeuropa aims to be the one of the most attractive Volkswagen European factory in the sense that can achieve the maxima quality and productivity based on high product, infrastructure and collaborators flexibility.

- **Volkswagen Autoeuropa Mission:** VW Autoeuropa is a multiproduct production unit from Volkswagen Group that pursuit, quality of excellence in manufacturing process helped by a high qualified workers and technological innovation. Respect the labor relations and the environment according the sustainability model from Volkswagen Group.

Besides that, VW Autoeuropa adopts the VW Group Code of Conduct which represents a global vision of the company principles. In accordance with that VW Autoeuropa assume the responsibility to develop its activities with maxima integrity and transparency, encouraging all business partners to follow this same Code in their own companies.

- **Strategy of VW Autoeuropa:** The VW Autoeuropa strategy has five bases: **1. Growth:** explore new opportunities of business, become a unit of niche business for services supply to the Group; **2. Transport:** explore the its geographic location as a competitive advantage; **3. Human resources:** health and well-being, development of competences and motivation of employees; **4. Responsibility:** projects stimulation in the area of environment, culture, sport and social responsibility; **5. Innovation:** every above mention is develop around the focus in continuous innovation and according the project *Mach 18 factory*.

- **Value Chain and Supply chain:** VW Autoeuropa Value Chain is divided in 4 main areas,¹³ its qualitative analysis permits to consider that group of activities that contribute more for the value generation is focusing on the supply chain, so by optimizing costs contribution of its central activities will generate higher profit margins. The Supply Chain management covers the flows of goods from supplier through manufacturing and distribution chains until reach the end user and is managed by the logistic department. Autoeuropa has a total of 678 suppliers: 63% in Central Europe, 2% in West Europe, 26% in South Europe, 9% in others. Regarding the inbound transportation, their major partners are: Transésé, Schenker and Rudolph Gruppe. VW Autoeuropa has a constant need for maintain a strong relationship with suppliers and carriers in order create alliances and benefit both sizes. This has a special importance since the implementation of JIT approach requires more frequent deliveries from supplier, rigorous information, and an higher focus in carriers and modes of transportation that can offer more reliable services not only the least costly (Christopher, 1992). Suppliers and carriers constitute important stakeholders and networks of automotive companies that have to be mapped and managed consistently.

¹³ Consult Annex 7: VW Autoeuropa Value Chain description

●**Industry Mapping:**¹⁴ The VW Autoeuropa' stakeholders are organizations and individuals with some interest in the company's activities and power to influence it choices. The ones that relates with the supply chain in the process of inbound transportation are: **Community** who have power to influence the public opinion (e.g. Media regarding environmental aspects), **Government**, who can act through legislation (e.g. promote the automotive sector and invest in infrastructures), **Suppliers and Carriers**, who are crucial stakeholders in the supply chain, normally with low influential power in the organization. The plurality of parts needed for automotive production imply that automotive companies have a complex and huge supplier network, and therefore, these stakeholders have a high interaction with the company and the cooperation between both is essential for the automotive industry.

5. Internal Analysis

A. Autoeuropa VW Logistic department characterization¹⁵

The logistics drivers are facilities, transportation and inventory. Transport products throughout the supply chain and arranges for optimal modes of transportation, are the main responsibilities of logistics functions, and therefore assumes a major importance in organizations. Transportation policies can also influence to achieve a strategic fit (e.g. find the right mix of responsiveness and efficiency).¹⁹

VW Autoeuropa logistics Strategy, Objectives and KPI's:

	AREAS			
	PROFIT	CUSTOMER	GROWTH	PEOPLE
Objectives	•A healthy profit	•The best customer satisfaction	•A sustainable growth	•A great place to work
Goals	•Costs optimization per unit	•40% delivery to Schedule •Less customer complains	•20% volume increase (against year start) •Top 20 in the accountability rating •Accommodate 20% per month volume fluctuation without infrastructure or equipment change	•74% green evolution; 95% participation in the Stimmungs barometer
Strategy	•Maximize income •Minimize costs	•Right time •Premium quality	•Maxima flexibility •Maxima business opportunity •Development of Corporate Social Responsibility	•Take care of people •Motivate & develop people •Attract talent
KPI's	•Factory costs per unit (2850€) •Total inventory (4,5 days) •Overhead costs (450€/car) •Labor costs (900€/car)	•Tagesgenau ¹⁶ (40%) •Program achievement ¹⁷ (100%) •Mix achievement ¹⁸ (93%)		•Health care rate (99%) •Training plan, training need fulfillment (100%) •Continuous improvement (per area) 3 workshops •Medical restrictions (<10)

¹⁴Consult Annex 8: VW Autoeuropa industry mapping (Stakeholders illustration).

¹⁵Consult Annex 9: Logistics organization

¹⁶Improvement project: void produce car in advance or in delay, daily production according the orders, avoid disruptions in the production, the car bodies cannot be more than 5 hours in the colors warehousing.

¹⁷Daily order send to the beginning of the body; quantity is according the program in force; orders send with 12 day in advance because supply commitments.

¹⁸Flow of order send for the final assembly according a list of restrictions managed by the industrial engineer (allow for a homogenous sequence of production)

¹⁹For example: faster transports increase responsiveness but it decrease efficiency, because of higher costs associated.

B. Major problem Analysis and Discussion:

• Problem characterization and Project objectives:

In industrial companies, transportation is one of the most important areas with higher costs therefore, this represent a possibility to achieve significant gains of productivity (Machado, 2006). The JIT concept is only possible if developed efficient and adequate transport network and logistics structure to support it. Currently in the VW Autoeuropa 90% of costs related to inbound transportation correspond to land transportation namely truck. Being the truck the primary transportation mode used for carry inbound components in the VW Group and despite strong advantages like high flexibility, no geographic limitations and high competitive for short distances, there are several disadvantages of this transport: limit load size, very dependent of traffic and infrastructures conditions, very constrained by legislation, more expensive for huge distances and high pollution transport. The cost structure of truck transport is low fixed costs (highways publicly supported, labor) and medium variable costs (fuel, maintenance). However, VW Autoeuropa already start developing alternatives for truck transports and thereby in December 2011 start as try-out the rail transportation. Currently the rail transport as a frequency of one a week, contains 2 routes for inbound and outbound materials and allowed for a reduction of 31,65% of CO₂ levels comparing with truck transportation. More factors that corroborate the need for an alternative transportation mode are that the average suppliers distance is around 3000Km and the current transport costs are the higher cost in the overall plant costs. Thus the main goal of this project is the optimization of inbound transport, by evaluating the relevance of a maritime transportation, regarding a specific geographic zone. It aims to consider possible economies of scale (the more items transported the lower the transportation costs per item) and economies of distance (the longer the distance moved at one time, the lower the unit cost per Km). The cost saving approach will compare the actual routes and transports used and the maritime alternative studied, taken into consideration the costs, levels of inventories and risk associated. The challenge is to select the right mode or combination of modes (rail, truck, water) and create an integrated service characterized by high specialization level, efficiency and professionalism. To large companies which operations have growth geographic expansion, is very important to lower the carrying costs, which far outweigh higher transportation costs when rapid delivery is an emergency (Christopher, 1992).

C. The relevance of a Maritime Option

Reasons to develop and invest in the new maritime opportunity:

Because transports are a critical part in logistics and challenges as: new legislation in transport sector, instability in energy markets, new cost structure and change of environmental paradigm, have growth, is important to find economic and environmental transports solutions.

The maritime transportation project, explore some new opportunities:

1. Endorsement of more responsible and efficient strategies - adoption of new policies and alternatives of parts transport: The transportation strategy followed by VW Group is heavily reliant in the truck transport and the desire for diversification/change doesn't exist until now.²⁰ Because of that, VW Autoeuropa itself is starting to invest in developing alternatives transportation projects, that may turn viable the adoption of others transportation modes, substitutes of truck.

The maritime transport as evolve to access to new technologies and practices that represent innovative solutions for the transport task (like the Ro-Ro transport) searching for an overall improvement in the operational efficiency and aiming competitive gains. It has also been highlighted by its ecological advantage of very low pollution (Machado, 2006). The maritime transportation is most effective when linked to a multimodal system. A key issue is the information exchange and the number of intermediaries in the process. A proof of this is the increased use of containers for shipping with rise of global trade (Lorange, 2009). Therefore ports are becoming intermodal terminals in the supply chain systems that add value to the port users and final customers (Karatas, Güldem, 2010).

2. Exploration of intercontinental routes: Whit roughly three-quarters of the earth's surface covered in water, it is needless to say that shipping plays a major role in the world trade and is effective the dominant mode of transportation in global trade. As advantage, maritime transportation permits a better coordination of supply chain in a global vision. VW Autoeuropa suppliers have a huge geographic dispersion all over the world and with globalization and development of emerging countries this tends to increase.²¹ Therefore the maritime option becomes a more viable solution for distant suppliers.

3. More/new investment of Government in transports' economy and infrastructures: The government has a decisive role regarding the firms' logistic area. It is responsible for creates solutions to help companies, developing structures and infrastructures to facilitate their operations (local and international) and incentivizing the diffusion of logistic knowledge.

In Portugal the legislation in transports doesn't help to people change their business mind. The reality is that the major transport used is the road, namely the small trucks, that normal doesn't do far distances. Under the Strategic Plan for Transports of Portuguese Government (2011-2015) is planned more investment in the maritime sector (seaports) for improve the structures and increase the competitively of the country, aiming to boost: exports, employment creation and economic growth. The adoption of VW Autoeuropa, a very significant company in

²⁰All inbound transportation (excluding urgencies) in Europe (where is the majority of VW suppliers) is made by truck. This is the strategy followed by VW Group which invest in optimize this transportation mode and don't diversify.

²¹VW Autoeuropa has suppliers from all continents; e.g. has suppliers located in Mexico, Morocco, China and all over Europe.

Portugal and special in the area of Setubal, for maritime transport will make more pressure for the Government invest in the sector and improve the Portuguese infrastructures (*“Plano Estratégico dos Transportes - Mobilidade Sustentável”* of Portuguese Government; 2011-2015).

4. Stimulation of maritime activity and seaports activity in Portugal: Portugal has lack of infrastructures to implement intermodal transportation using the maritime transportation. The Portuguese seaports must be converted in pivot hinges of transports chains so that can offer appropriate conditions for companies choose them for transport their products: competitive costs, reduced transit times and high reliability of service. Data of 2002 shows the maritime transport in Portugal, is the more used for imports followed by the truck and the air and rail represent a few percentages; in the case of exports the preferred is firstly the truck (probably because the majors export destinations are countries close to Portugal), then the maritime and again the air and rail represent a low percentage (Machado, 2006).

5. Decrease of transportation costs - cost efficient solutions (economies of scale): The maritime transportation has a very competitive price special for huge volumes transported or heavy loads, representing a great relation price per ton/cubic meter. In Automotive industry this is an important solution for transportation of parts and final products since the goods transported are normally very bulky. The major factors that impact in the shipping costs are fuel, crewing and maintenance (Lorange, 2009). Other market that can influence the price charged by maritime transport are the degree of competition in the shipping industry, the location of the markets, the distance between load and destination ports and the freight rates charged, which differ from seaport to seaport (Arantes, 2005). Its cost structure is: medium fixed costs (ship contract rent and equipment) and low variable costs (transport a large tonnage) which shows the relevance of economies of scale to the sector.

6. Explore the exceptional Portuguese geographic location as a competitive advantage: The Portuguese world geographic positioning is a very excellent localization since it is in the center of the world. The frontier localization of Portugal in West Europe where converge maritime traffic of all over the world, the Portuguese long maritime costs, the large dimension of Exclusive Economic Zone are translated in unique competitive advantages which Portugal must invest to potentiate. The maritime transport is responsible for 72% of the international commerce. Based on that, the Portuguese sea is a strategic asset and the maritime sector could play a fundamental role in the development of the country' economy by develop an easier access to distant market where the terrestrial transport represent a hard challenge.

7. Creation of a logistics “HUB” (Intermodal Strategic Point) with growth potential for other materials: Portugal has a high potential for become the Atlantic logistic platform. Despite the lack of infrastructures Portugal has a unique set of condition, which, if developed can lead to Portugal grow into a world important transcontinental multimodal logistic platform,

becoming an open door of entry and exit of goods of Europe to America and Africa continents. To achieve this, a development of an integrated transports strategy is fundamental (a creation of distribution channels with intermodal transportation between maritime, train, and truck). However, there are also disadvantages of maritime transportation: the most outstanding is the increase of transit time and consequent increase of inventories because the maritime transport is the slowest of all the transportation modes, the low flexibility: restricted to locations with water access and increase risk volatility due to delays that can occur at seaports.

D. General analysis of transportation actual situation at VW Autoeuropa:

As already explained, the inbound transportation in VW Autoeuropa is mainly through mega truck transports in two types of processes: normal or special process. The normal process, consists in 2 circuits: from the supplier to a VW consolidations center in Germany (made through a regional carrier) and then from the consolidation center to VW Autoeuropa (by another transport company which load the material in an optimize truck). This process path includes 3 different transportation costs: transportation costs from supplier to the consolidation center, the cost of handling in consolidation center, and finally the transportation cost from the consolidation center to VW Autoeuropa.

When it is identified suppliers with big volume of transportation, in order to win efficiency, VW Autoeuropa develop alternatives ways to transports these supplies, named as “direct load” and “milkruns”. In “direct load” there is only 1 supplier involved in the process and in “milkrun” are combined two important suppliers geographically closed, aiming the optimization of the truck. Either the “direct load” or the “milkrun” the truck come directly from suppliers without intervention of consolidation center. This generates just one cost, the transportation cost, and is beneficial because has lower intermediaries involved resulting in low cost per cubic meter.

6. Operation Plan

A. Analysis Methodology

• Current situation analysis - Criteria to analyze the Eastern Europe zone:

The Eastern Europe zone (including Turkey and Italy) was chosen based on the criteria of being the most distant zone of Europe with relevant suppliers, and therefore represent higher truck transportation cost; the existent of a considerable number of critical suppliers which translate into possible higher savings when optimized and by last the fact that this region is not very distant from sea coast and have accessibilities to seaports.

Why exclude Germany: being Germany a market, that besides Portugal is the one with more importance at a supplier’s level, is already much more optimized. Therefore the possible

savings of a maritime transport would not represent savings as large as in more distant locations where the maritime is more needed.

- **The first approach was the Billing Analysis:**

By focusing in the analysis of weights and volumes, regarding the first five months of 2013, was aimed the selection of countries, inside the world chosen zone of analysis (“Eastern” Europe), and the initial evaluation of suppliers inside those countries based on billing values. The set of countries analyzed were: Bulgaria, Slovenia, Romania, Hungary, Czech Republic, Slovakia, Austria, Turkey, Italy and Poland.²²

The constrain factors to exclude supplier or even countries from the analysis:

- **Quality impacts on the parts transported:** The maritime transport is subject to more environmental conditions and therefore, parts whose quality could be affected should not be transported by maritime, because will add more quality control costs or will result in not operational parts which will have to be replaced. The materials that require precautions, when transported by maritime, are ones flammables, explosive and the corrosive.²³

- **Distance to seaports:** Locations very distant to seaports will generate higher transportation costs and more logistical support to do it. In this cases will be more difficult to the carrier or VW Autoeuropa ensure the transport until the seaport and will probably include more intermediaries in the process which difficult the costs minimization. In these cases the trade-off between the actual cost and the savings which a maritime transport will allow will possibly not be sufficient to change the transportation already implemented since the major costs when implementing the maritime transport are related to task in the extremes of the process: transport until the seaport and then from Sines to VW Autoeuropa.

- **Types of package used:** The VW Group has its own packages that in partnership with suppliers use for carry the parts. There are three types of packages: general, specials and paper. All these have dimension optimized for truck trailers and not for containers. The paper ones don't offer concern since the supplier can adjust their dimensions, are more flexible, and so, can be optimized in maritime transport. The ones that are general are used by all VW factories and don't represent any constraint when VW Autoeuropa return them to suppliers because can do it to any location. The specials are the most worrying because are only used by the VW Autoeuropa factory and their suppliers, and consequently it must return the packages to suppliers. This involves an inverse logistics process which encompasses the activities related to the inverse path of information and materials representing a high amount of costs. This mean high extra cost since the concept of the maritime transport only considers transport from suppliers to Portugal.

²²Consult Annex 10: Billing analysis – first approach:

²³An example of a part excluded from the analysis was the motor engines because of being a corrosive material.

● **Volume quantity transported:** The quantity is probably the most important exclusion factor in the analysis. For transportation the quantity can be measure in volume and weight. Considering the characteristics of maritime transport it is more beneficial when transporting large volumes. And because the most relevant suppliers normally supply several car models production, representing high quantities of parts, these are the most indicated to transport via maritime. By excluding the less volume loads the risk associated to the maritime transport is minimized since these small loads would lead to the existence of a few supplies with low regularity (these supplies would bring parts for a bigger period of time) which would increase the likelihood of problem occurrence with that load and any variation in the consume of that parts would not easily supplied through maritime (reduced flexibility from small suppliers). In the analysis it was considered volumes and weight superior to 500 cubic meters and 70,000Kg²⁴ respectively (per supplier and for 5 month).

Conclusion: After this analysis from a total of 127 suppliers the result²⁵ was that only 20 suppliers of five countries remain (Hungary, Romania, Italy, Turkey and Czech Republic). Considering the high geographic distance to Portugal and the short number of suppliers in question, in Turkey were considered all the suppliers located.

Effective analysis of costs and volumes for the selected suppliers resulted from the analysis of constraint factors applied to the billing analysis:

The billing analysis is not the most accurate because only accounts the volumes and costs already invoiced by the carriers and may not represent the reality of the costs and volumes incurred. Additionally when analyzing only the first 5 months of 2013 there was a deviation in the volume numbers, because the production is not constant during the year and the second half of the year has more weak production months (i.e. August: summer vacations and December: Christmas time) which made the monthly average decrease when comparing with the first billing analysis. Therefore it was necessary to perform a most precise analysis in terms of volumes, weights and costs. In the effective analysis the data analyzed correspond to the entire year of 2013. This analysis started by identifying from each supplier the different parts and the parts' characteristics supplied to VW Autoeuropa for each supplier. Then through the dimensions of the package, the number of parts per package and the package and the parts weights were calculated the volume and weight of a complete package. The next step was to calculate the take rate, which consists in the percentage of use of each part in the production process. When a part has more than hundred percentage usage (take rate) means that it is used several equal parts in just one car like the screws. Then, multiplying the take rate by the annual volume produced it was reached the effective quantity needed from each part, and consequent

²⁴The quantitative analysis of weight is in Kilogram due to Data Base.

²⁵Consult Annex 11: Billing analysis – results after constraints exclusion

quantity of packages needed, to satisfy the production. Knowing that, it is possible to know the volume and weight required by year and also by week (multiplying by the package dimensions and weight). Finally was calculated the actual weekly/year transportation costs²⁶ and cost per cubic meter for each supplier (considering 45 production weeks). For the special cases which exist already an optimization, the evaluation of the transport costs was different: for “direct loads” and “milk runs” there are special contracts with the price per truck defined and the costs per a cubic meter and kilogram are calculated dividing that by the truck capacity. The result was that the less volume load pay more per cubic meter than the higher volumes, and the more distant ones, like Turkey, when conciliated with small quantities achieve exorbitant costs values. Finally the inventory costs²⁷ were calculated based in the EOQ Model²⁸ (taking into account the safety stock plus average stock) and the inventory costs result from the sum of the storage costs and capital employed cost. The inventory costs was calculated per week and then per year as unit of time. In Annex 14 it is possible to consult a resume table with the total volumes and weights per supplier, the transportation and inventory costs for each country and an estimation of the number of containers that correspond to the volume studied.

The Maritime Option:²⁹

- **Maritime containers:**³⁰ The maritime container transport is the main used for finish goods shipping. This shipping segment has faced a high growth, given the rise of global trade and technology developments becoming fiercely competitive. The size of ships has increased (appear the mega ships) and ships speed has also increased. Standard containers are used for all kind of commodities and fit on trucks, railway trailers and vessels. China is a key for worldwide shipping markets but also other regions are important like Europe, Japan and US (Lorange, 2009).

- **Seaport available:**³¹ Currently it has occurred an accelerating competition process in the maritime transport and seaport business sectors. Factors such as proper hinterland connections, available port infrastructure and equipment, qualified port labor, differentiated port services, efficient cargo and information flows define the role and importance of seaports (Karatas, Güldem, 2010). In Turkey the main industrial ports are Gemlik, Bandirma, Aliağa, Antalya, Mersin, Yarimca, Istanbul, Izmit, İskenderun, Hopa, Inebolu, Samsun, Trebizonda e Zonguldak, however the last five don't were considered in the analysis because are located in the Black Sea and therefore not optimize a maritime route to Portugal. All of them have big dimensions; therefore will be chosen according the carrier relevance in those ports. Others

²⁶Consult Annex 12: Effective Analysis of transportation costs

²⁷Consult Annex 13: Effective Analysis of inventory costs

²⁸Consult Annex 13: Theoretical explanation of Inventory analysis/calculation

²⁹Consult Annex 17: Factors taking into account for decide the new maritime transportation possibility

³⁰Consult Annex 18: Container Specifications

³¹Consult Annex 15: Seaports analysis

regions studied was Croatia and the its seaports: Ploce, Rijeka and Zadar, and the Italian seaports: Genoa, La Spezia, Livorno and Savona (are the major seaports in the regions more close to the Italian suppliers and also represent shorter routes to Portugal) which represent a better tradeoff between suppliers distance³² to seaport and maritime transit time versus total maritime route distance.³³

Regarding the Portuguese seaports the question was between Setúbal or Sines ports. All Portuguese seaports reveal a tendency of growth. Setubal port is the continuous preferential platform used by VW Autoeuropa for export its production through the Ro-Ro terminal specialized for this segment (almost 95.000 vehicles export in 2012 through this port).³⁴ However the Sines port brings the possibility of receive large ships because of their water depth.³⁵ The Sines port is the major responsible for the maritime traffic in Portugal and the principal export seaport (5 million ton in 2010). Since 2004 growth 135% in exports enhance by its XXI Terminal which offer direct connection to all continents. Sines port has good infrastructures which ensure reliability of operations and has continuing invest in increase the maritime connections and carriers, and the improvement of port services (e.g. truck transport door-to-door) aiming to transform in a logistic HUB opened 24 hours.³⁶

- **Evaluate the possibilities of parts collection from suppliers until the load port:**

The possibility of have a “consolidate center”: the maritime transportation when involved several suppliers not geographically closed turn necessary to exist a place where the consolidation of the cargo (from different suppliers) can be done and then be prepared for shipping in a sea container. This task can be responsibility of several intervenient: it can be done by the suppliers: currently the VW Autoeuropa suppliers don’t have this kind of service available; by the VW Autoeuropa subcontract company (regional truck carrier) which involves a VW control and coordination of the processes. The current VW Autoeuropa already use regional carriers to deliver supplies in the German consolidation centers and therefore these carriers can continue to be used, however they haven’t a warehouse to consolidate the cargo; and finally by the shipowner through collecting the parts from suppliers and consolidate them after in a warehouse owned by him. This is the most desirable option, since, reduce the number of intermediaries in process and reduce the VW control needed, which consume time/resources and increase logistic complexity.

The possibility of doing it through a “milkrun” collection: considering the higher costs and more complex logistic process, inherent to the possibility of consolidate the cargo, another

³²Consult Annex 16: Western Europe Map with supplier’s distance to seaports

³³This means that Croatia port are in reality more close to the Western Europe suppliers, but the maritime route associated to that ports have higher transit times because are more distant of Portugal

³⁴From “Porto de Setúbal afirma ser a aposta da AutoEuropa”, Transportes em revista’ magazine

³⁵From “Porto de Sines movimentou 27 milhões de toneladas”, Transportes em revista’ magazine

³⁶From “Future Auto Industry to Have Fewer Platforms, New Growth Markets” WARDAUTO’ magazine

possibility appears high beneficial for the maritime project: the “milkrun” collection.³⁷ After this collection the container truck will deliver the sea container in the respective port of load for the maritime company ship the cargo until Portugal. This option represents the most simply and currently viable because all the restrictions related to the consolidation center option and because VW Autoeuropa as already experience with “milkrun”.

B. The new maritime transportation option:

The carrier partner of VW Autoeuropa in this maritime transportation project is MG2, a global transporter that operates as independent carrier, high specialized and with unparalleled service network (by 2013 was operating 459 container vessels). MG2 was selected because represent a existent contact of VW Autoeuropa and it currently works with VW’ suppliers present in VW Autoeuropa industrial park which demonstrate it reliability of services. However the final choice of carrier is done by VW Logistic Group.

The industries that spend a lot of money in transportation costs, like automotive industry, know that a high portion of these costs are related with the last mile, the last phase of supply chain. Because of that, reduce the number of intermediaries in the process of transport and turn it the simplest possible, is mandatory. MG2 competitiveness is in the container transport’ market and it is within this solution that MG2 present it best offer in terms of costs consequence of its efficient worldwide network, specialized in this ship transportation segment.

Concluding the option chosen for transport the cargo, in maritime transport, was the container vessel. Regarding the part’s collection from suppliers until de load port this will be done through a “milkrun” collection.

C. The maritime routes - explanation of routes step-by-step:

After contact maritime carrier, MG2, the result was the creation of 3 possible routes for the group of 20 suppliers from 5 different countries (Turkey, Romania, Hungary, Czech Republic and Italy). The routes chosen are the ones that offer the most competitive alternative to actual transport, given suppliers volumes and distance to seaports.

- **The “Turkey route”** involves 8 suppliers (all the suppliers placed in Turkey) located in the west and north region of Turkey. The Turkey seaport chosen was Aliaga seaport because offer a direct service to Sines seaport and therefore has a shorter transit time of only 4 days. The route starts with a “milkrun” collection done by a regional carrier that will first piking the empty container in Aliaga seaport or in Istanbul container terminal (depending of the proximity to the suppliers) and then pass by all suppliers and collect their loads in sea containers until load all cargo and finally will deliver all containers in Aliaga seaport to the care of MG2. After

³⁷The “milkrun” collection consists in the following: a container truck would get an empty sea container from a terminal of containers or from a seaport (depending from each is closer to suppliers) and then it would collect from the suppliers involved in that route all the cargo until the container is full.

that, the shipment comes through the Aegean sea until arrive the Sines seaport in Portugal and finally MG2 deliver the cargo in VW Autoeuropa facilities. In total this route will have 6 days of transit time because additionally to the 4 days by sea it is necessary one more day for collect the cargo from suppliers to the seaport and then one more day from Sines seaport to VW Autoeuropa facilities.

“Turkey route”
image



- The **“Italy route”** is more complex since involve several countries: Italy, Romania and Hungary and a total of 9 suppliers. The load seaport for this route is La Spezia, in Italy, because from all Italian seaports where MG2 operates, this is the only that offer a weekly frequency of 4 shipments direct to Sines with a maritime transit time of merely 6 days. In this route the parts collection process is also “milkrun” collection and then is delivered all the cargo in the La Spezia seaport. The empty container terminals used can be Budapest for Romania and Hungary and La Spezia for the Italy region. Arrived to Sines seaport all the cargo will be delivered by MG2 to VW Autoeuropa factory. In total, this route will have 9 days of transit time, because, additionally to the 6 days of maritime transit, it is necessary 2 more days for collect parts from all suppliers involved and finally from Sines seaport to VW Autoeuropa facilities takes one more day of journey.

“Italy route”
image



- The **“Croatia route”** involves also more than one country: 2 suppliers from Romania and one from Hungary, however they are geographically close to each other. The load seaport of this route is Ploce, a Croatian seaport, because is the one closer to suppliers and has the same transit time of other Croatian seaports available. Despite the reasons above mentioned of the Italian seaport being advantageous because have lower transit times, it was considered a route from Croatia because the maritime transportation costs are very similar between Croatian and Italian seaports and with this route was aimed the saving in transportation costs between suppliers and seaports. The suppliers’ collection process is also the “milkrun” collection, and the nearest containers terminal for collect the empty container is in Budapest. The total transit time of this route is 16 days: 14 days by maritime transport (the ship make a transshipment in Gioia Tauro, Italy), one day for parts collection from suppliers and one day in Portugal to unload the cargo from ship and arrive to VW Autoeuropa.

“Croatia route”
image

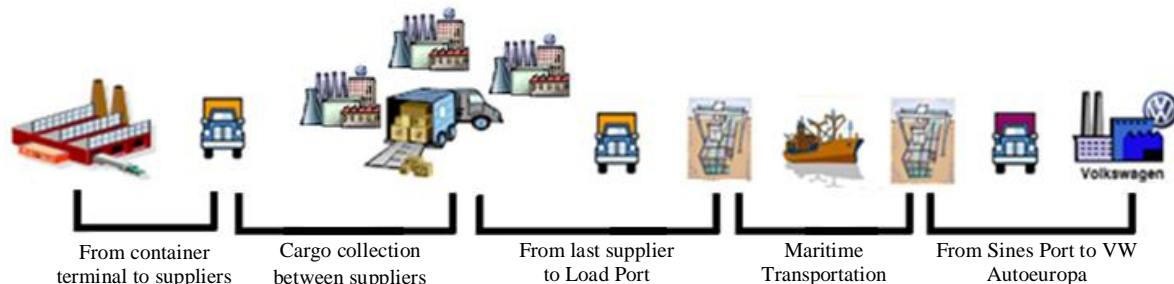


All routes follow the same transportation process: initiate with a “milkrun” collection, to join all the cargo to be shipped (in an order that minimize the distance travelled) and then when the truck is full, it goes to the respective load port, as already explained.³⁸ The maritime transport is made in a container vessel and can do scale in other seaports or goes direct to Sines seaport. Arriving to Portugal, Sines seaport, the containers are again transported by truck until the VW Autoeuropa facilities.

Regarding the responsibility division, all routes will have the same responsibility assignment: the task of collect the cargo in suppliers is responsibility of VW Autoeuropa because in this way can achieve more competitive prices given the current relation that already has with regional carriers. The tasks of maritime transport between load ports and destination port and then from Sines port to VW Autoeuropa location is responsibility of the carrier MG2.

Illustrative diagram of the new maritime option

Inbound transportation by maritime mode “Route split” (with transit times):



D. Routes analysis - current situation (transportation and inventories costs):

- The “Turkey route”:³⁹ has a total volume of 484m³ and almost 37.205Kg per week, representing a total of eight 40’ standard containers and one 20’ standard container. In these set of suppliers there are important suppliers as supplier n°2 and n°8⁴⁰ that have high take rate and impact in all car models produced but there are also suppliers (e.g. supplier n°6) with low volume and take rate. The transit time of this country currently range from 12 to 15 days, being the one that takes more time to arrive VW Autoeuropa. The transportation costs from Turkey

³⁸All collection routes planned were done in order to optimize the number of trucks used and an example can be consult in Annex 21: Map of land routes for collection supplies until load port (Turkey example)

³⁹Consult Annex 19: Turkey map

⁴⁰Supplier n° 8 is currently present in another country however is predicted that will in a close future be relocated in Turkey. Therefore this supplier was considered in the analysis.

has a weekly value of almost 27.972€, ⁴¹ detaining one of the higher transportation costs per cubic meter for some suppliers (values that surpass 500€ per cubic meter). The inventory costs are approximately 1.324.784€ per week having the higher ratios of safety stock days, consequence of higher transit time periods. Because all these, it represents an important case for improvement.

- **The “Italy route”**⁴² hold up a set of suppliers extremely relevant since their take rates are in average very high and affect all car’ models produced. They represent a total volume of 520m³ transported per week (208m³ from Italy, 165m³ from Romania and 147m³ from Hungary). Representing a total mix of nine 40’ standard containers and one 20’ standard container weekly transported. The current transit time of these countries array from 8 to 10 days and the higher values respect to Italy, Hungary as an average of 8 days and Romania has 9 days. Because this involves a large number of suppliers/volume transported (total of 9 suppliers geographically distant) the existing transportation costs represent approximately 19.017€ per week. The inventory costs are very high, 1.377.684€, consequence of the transit time period and high number of suppliers in this route.

- **The “Croatia route”**⁴² involves less suppliers than the others routes and therefore the volumes transported are much lower, representing a weekly value of 217m³. However it denotes a considerable volume to be shipped, representing a total of four 40’ standard containers. The actual transit time of this route is 8/9 days. The actual weekly transportation costs involved in this route are 8.453€ and the inventory total costs are 793.060€. Since this route contains suppliers that are also present in the “Italy route”, this route represents an alternative to “Italy route” and both cannot be performed at the same time. Because that, it can be affirmed that the suppliers present in this route are important suppliers also.

E. Maritime option costs:

The increase of global trading has resulted in growth demand for container shipping (around 10% per annum over the last few years). Since shipping companies search for more cost efficiency: by operating larger container ships to achieve economies of scale, by associating the shipping companies with seaport operations, storage, or even door-to-door truck delivery, freight rates⁴³ have become very competitive when compared with other transportation options. The recent trend is build up, on sea and land, an integrated infrastructure. The emergent of trade-offs, like: reduce the ship speed to saving in costs, however to maintain the same

⁴¹It’s not the exactly value since the costs of Supplier n° 8 was an estimation and not the current cots (calculated based on the volume costs of the most volume Turkey suppliers)

⁴²Consult Annex 20: Western Europe map

⁴³Freight rates are affected by the distance between the places where goods are manufactured and where are consumed.

frequency of service is necessary increase the number of ships needed and therefore increase costs of transportation which impact in price charged (Lorange, 2009).

Maritime transportation costs divided per “route split”:

1 st “route split”		2 nd “route split”		3 rd “route split”
Path between empty containers terminal, suppliers and load ports.		Path between load ports and the destination port (Sines port) - MG2 service		Path between Sines port and VW Autoeuropa facilities.
Global regions:	Average container truck costs per Km:	Load Ports:	Cost of maritime transport per container:	The costs per container (equals for 20’ and 40’ standard containers) from Sines direct to VW Autoeuropa factory is 200€ plus taxes
Turkey	Due to the fact that was not given any estimated actual value it was considered 1€ per km for the calculations	Aliaga	837 € - 20’cont.	
			1.187€ - 40’cont.	
Italy		La Spezia	787 € - 20’cont.	
			1.187 € - 40’cont.	
Western Europe		Ploce	987 € - 20’cont.	
			1.287 € - 40’cont.	

7. Final Analysis – compare maritime options with the current situation:

- Transportation Costs⁴⁴

TOTAL Maritime transportation’ costs divided per “route split”:

Maritime Routes	1 st “route split”		2 nd “route split”		3 rd “route split”		TOTAL COSTS	
“Turkey route”	3.711€	23%	10.332€	63%	2.214€	14%	16.257€	100%
“Italy route”	12.903€	48%	11.468€	43%	2.460€	9%	26.831€	100%
“Croatia route”	4.200€	41%	5.147€	50%	984€	9%	10.331 €	100%

In “Turkey route” the total transportation costs, of transport eight 40’ standard containers and one 20’ standard container, are 16.257€. With this route VW Autoeuropa will achieve saving of 11.715€ in transportation costs per week which represent a year saving of 527.175€ (42%). It is a high considerable value and therefore is an important opportunity for VW Autoeuropa reduces its transportation costs and achieves its costs and efficiency objectives.

In “Italy route” the total transportation costs, of transport nine 40’ standard containers and one 20’ standard container, are 26.832€. With “Italy route” VW Autoeuropa will not reach a saving in transportation costs, the result obtained was a negative saving of 7.815€ per week (-41%) which mean that this route will not represent an opportunity to explore.

In “Croatia route” the total transportation costs, of transport four 40’ standard containers, are 10.331€. With this route VW Autoeuropa will also not accomplish a saving, having a negative saving of 1.879€ (-22%) in transportation costs per week.

Savings in Transportation costs per week:

Maritime Routes	Actual cost	Maritime costs	Saving	
“Turkey route”	27.971€	16.257 €	11.715€	41,88%
“Italy route”	19.016€	26.831€	-7.815€	-41,10%
“Croatia route”	8.452€	10.331€	-1.879€	-22,23%

- Inventory impacts⁴⁵

Inventories serve to cover up unexpected problems. The key objective is to reduce and control inventory to the lowest level possible while simultaneously achieving operating

⁴⁴Consult Annex 22: Comparative analysis of Truck and Maritime transports – costs analysis

⁴⁵Consult Annex 22: Comparative analysis of Truck and Maritime transports – inventory analysis

objectives (Christopher, 1992). Theoretically the maritime transportation option (less costly) increase the risk associated with transportation task and increase the transit time periods, which has the consequence of increase the safety stock, resulting in the increase of average inventory - transportation and inventory cost trade-off (Goebel, 2009). The rise of inventories levels led to a growth of capital immobilized costs, loss flexibility and competitiveness, since decrease the available capital for new investments (Machado, 2006). With the new maritime reality analyzed, the results in the inventory are:

In “Turkey route” the current value of inventory costs is 1.324.784€. With the adoption of the maritime transport the value of inventory costs related to this route will change for 975.834€. The decrease of the costs is due to the fact that the transit time is largely reduced which enable a decrease of the safety stock quantity needed as safeguard. Thus this will enable a saving of 348.949€ (26%).

In the “Italy and Croatia routes” occurs the opposite case. The levels of inventory costs registered at the moment are: 1.377.684€ and 793.060€, and with the maritime transport they change for: 1.503.006€ and 973.368€ respectively. The increase of the costs are marginal values, since in the case of the “Italy route” the transit times still the same and the Italian seaport of La Spezia offer a weekly frequency of 4 shipments direct to Sines seaport, minimizing the risk of delays, the decision was to maintain the levels of the actual safety stock or increase lightly for high critical parts. In the case of the “Croatia route” the transit time increase approximately 7 days, however due to the fact that the safety stock level were already high for that suppliers, the increase of safety stock values was not very representative resulting in a low increase of the inventory costs. To calculate the negative saving in the inventories costs for both routes it is correct to consider an opportunity cost of capital because the increased of the capital employed in the stock levels could be invest in others opportunities that will benefit the company. Therefore the opportunity costs rate considered was 8% and the calculated negative savings are: 135.348€ and 194.733€. This stock alteration occurs only in the project beginning and then can be adjusted according the performance of the processes; therefore the inventories saving occurred only at one time in the project.

- **Comparative Route Savings – Trade-offs:** The trade-offs in transportation design are: the transportation cost and inventory cost trade-off⁴⁶ and the transportation cost and customer responsiveness trade-off.⁴⁷ Regarding the maritime transportation mode, it is a cheaper transportation, typically associated to longer lead times and involve larger minimum shipment

⁴⁶This trade-off balances the choice of transportation mode and the physical inventory aggregation

⁴⁷Trade-off which balance the choice of transportation mode and the temporal inventory aggregation.

quantities, resulting in higher levels of inventory⁴⁸ and lower transportation cost (Sanders, 2012). In the maritime routes analyzed don't verify this trade-offs, since in the "Turkey route" both transportation and inventory costs decrease and in the "Italy and Croatia routes" both costs increase by the reasons already explained.

Comparative Routes' saving Analysis:

Maritime Routes	Transportation cost Savings	Inventory costs Savings	TOTAL SAVING in 1 st year
"Turkey route"	527.175€	348.949€	876.124€
"Italy route"	-351.675€	-135.348€	-487.023€
"Croatia route"	-84.555€	-194.733€	-279.288€

- Environmental analysis - benefits (CO₂ savings)⁴⁹

The maritime transport is probably the transportation mode less polluter per ton transported (variable according the fuel quality or engine type). The road transport is much more polluting, makes more noise, and is more susceptible to accidents and congestions (Carvalho, 2002). Environmental vessel innovations special dealing with emission of gases has increase in order to converge to international conventions of environmental protection, legislations and bureaucratic requirements. Innovations around pollution control in ships are: fuel tank protection, emission compliance (CO₂, filters), antifouling paints, reducing speed, (reduction of 2 knots will generate in average a 25% saving in fuel consumption for a container carrier), weather routing systems, steady steaming (maintaining the speed during the journey), improved hull design, propulsion systems or low sulfur fuels (Lorange, 2009). When companies are choosing the transportation mode to use, the environmental consequences should also be taken into account. Companies that affirm to have environmental consciousness and high standards, like VW Autoeuropa, as the duty of develop more sustainable solutions in their logistics strategies, namely in the transport area.

With the currently viable maritime transportation option, the "Turkey route", VW Autoeuropa will achieve CO₂ savings levels of 1.443.873 KgCO₂ emissions that represent a 73% saving, see entire analysis in Annex 24. To convert the CO₂ saving in money it was used the carbon credit⁵⁰ analysis regulated by European institutions. The price of carbon credits from emissions trading system is currently around 5€ per tonne.⁵¹ The result is that that CO₂ saving of this project will represent a possible saving of approximately 7.220€.⁵²

⁴⁸Consult Annex 23: Transportation and inventory' cost Trade-off image

⁴⁹Consult Annex 24: CO₂ Analysis

⁵⁰"A **Carbon Credit** is a generic term for tradable certificate or permit representing the right to emit one tonne of carbon dioxide or the mass of another greenhouse gas with a carbon dioxide equivalent to one tonne of carbon dioxide. Carbon credits and carbon markets are a component of national and international attempts to mitigate the growth in concentrations of greenhouse gases..." know more in http://en.wikipedia.org/wiki/Carbon_credit.

⁵¹Reference:http://www.wikienergia.pt/~edp/index.php?title=Pre%C3%A7o_do_carbono_desce_abaixo_de_5_euros/tonelada_no_esquema_da_Uni%C3%A3o_Europeia

⁵²References used: <http://br.investing.com/commodities/carbon-emissions>,
<http://www.presseurop.eu/pt/content/news-brief/1314561-parlamento-europeu-reavalia-tonelada-de-co2>

8. Risk Analysis

Risk is an uncertainty; acceptable risk will depends on the risk-taking propensities of the decision-makers. Shipping is exposing too many exogenous factors more than others industries. Is fundamental for a correct risk level assessment (not eliminating risk, but quantify and control it) a good understanding of the shipping transportation and shipper company. If there is discomfort over risk exposure, management should consider risk insurance or securitized. Implementing risk management strategies in the increasingly sophisticated and competitive environment can often make the difference between stay in the business or not. The result of risk analysis is a more prudent approach to the maritime transportation and contribute to maximize savings, through avoid exceptional expenses not previously expected (Song, Panayides, 2012; Christiansen, Fagerholt, Ronen, 2013).

Resume Table of Risk identification and classification (see entire Table in Annex 25)

Top 4 Risks	Causes	Probability of occurrence	Project impact	Reasons/justifications:
Delay of the shipment delivery	<ul style="list-style-type: none"> Weather conditions External factors (like strikes) Technological problems (e.g. problem in port informatics system) Ports delays due to congestion Conditions of Infrastructures, including their access facilities Human Error 	<ul style="list-style-type: none"> There is a high/medium probability that a delay occurs given the innumerable causes that can contribute to that. 	<ul style="list-style-type: none"> Is the risk with higher probably of occurrence. Therefore the predicted savings of the project can disappear if the company occurs in too many extra costs to urgent transportations problems. Concluding the impact of the risk of delays is moderated. 	<ul style="list-style-type: none"> Ships have higher uncertainty in their operations, higher dependence on weather conditions and technology. With the intensification of global trading the harbor infrastructures has not been enough improved to managing this growth. Currently with the world crises it is more usual for countries with difficulties that strikes may occur and affected the economic activities There is a safety stock which aim to satisfy production demand when delays occur and therefore reduce the risk impact of delays.
Product Quality impact	<ul style="list-style-type: none"> Weather conditions Human error 	<ul style="list-style-type: none"> There is a low probability of this risk occurs since was excluded from the analysis parts which quality could be affected. 	<ul style="list-style-type: none"> The impact of this risk will be moderated/serious depending of the value of the parts in question. 	<ul style="list-style-type: none"> Although it were excluded the products more quality vulnerable from being transported by maritime as a precaution to prevent negative quality impacts and additional costs, a container inside a ship can suffer some damages special when there are critical weather conditions. The impacts can be reduced because transport insurance.
Miss a delivery of a shipment	<ul style="list-style-type: none"> Accident or Human fail Prediction or occurrence of bad weather with impossibilities the ship circulation 	<ul style="list-style-type: none"> The probability of occurs is low/very low because ships are much safety nowadays. 	<ul style="list-style-type: none"> The impact of this risk occurs is serious because will lead to the need of develop extra efforts to bring all the parts that miss delivery. This will represent a high costs if the safety stock would not enough to cover the entire shipment that miss. 	<ul style="list-style-type: none"> Ship safety' regulations are being tightened and it represents a concern for bulk carriers. Technological developments help to avoid accident caused by weather. Also help to information flows and mistakes identification. More qualified experts driving the ships avoid errors Given the short path in question and the Mediterranean weather' characteristics even in the Winter the maritime conditions are normally good for large ships do the transportation of supplies.
Changes (increase) in freight rates	<ul style="list-style-type: none"> External factors: changes in fiscal standards, Economic cycles, Port delays Vulnerability to oil prices, Trade barriers Container ship market' capacity 	<ul style="list-style-type: none"> The probability of occurrence is medium because contracts can difficultly be adjust and companies not easily accept price increase. 	<ul style="list-style-type: none"> The impact this risk occurs is minor because there is a strong competition in the shipping segment and VW Autoeuropa have a high bargain power in negotiation. 	<ul style="list-style-type: none"> The Political issues, economic booms and recession cans seriously impact the shipping industry. The port congestion can result in higher transport freights rates since ships tend to work at full capacity. The container ship market' capacity is expected to not influence shipping rates because strong economic outlook in consumption areas such as the US and Europe and a strong outlooks and competitive cost levels for manufacturing regions in Asia (China).

In the Risk Management Plan,⁵³ is made a risk evaluation which consists in identify the 4 top risks, assess their risk probability and impact and based on that assess the risk criticality.

Correspondences to the top 4 risks previously identify:

Top 4 Risks:	Probability	Impact	Criticality
Delay of the Shipment delivery	3.5	3	10.5
Product Quality impact	2	3.5	7
Miss a delivery of a shipment	1.5	4	6
Change (increase) in freight rates	3	1	3

The result was that: the Delay of the Shipment delivery was considered a moderated risk, which can affect the budget and impact the project defined objectives (like cost saving), and the Product Quality impact, Miss a delivery of a shipment, Change (increase) in freight rates were considered low risks which mean that have a low influence (costs) on the maritime transportation project.

9. Contingency Plan:⁵⁴ It is important develop an effective and efficient Contingency Plan to implement in the case of emergency. It should have the lower cost possible and lower negative impacts in the final consumer or plant activity. The Contingency Plan results from the risk analysis because according the risk evaluation creates several problematic scenarios and respective solutions to adopt. Solutions are also dependent of the responsibilities division, namely who must act for each case and who is responsible for the costs of the solution. The objective of VW Autoeuropa is adopt solutions without extra costs for itself. According to the risk analysis the Delay of the Shipment was considered the risk with higher level of Criticality and consequently the one considered for problematic scenarios. See the detailed Contingency Plan in the annex 26.

10. Implementation of Operations Plan:⁵⁵ In order for this strategy to be a viable tool in the hands of the company, it should include an Implementation Plan. Such plan takes into account the guidelines and the timing of the changes suggested within this project. The plan takes into account bureaucratic and budget constraints.

11. Conclusions and Finals Recommendations: After the complete analysis performed in this Maritime project for inbound transportation in VW Autoeuropa the major conclusion to take is that exist an important opportunity to achieve cost saving in transportation costs. The “Turkey route” reveals be an excellent option to implement the maritime transportation in VW Autoeuropa and will generate a total saving of approximately 527.175€ per year in transportation costs (42%) and 348.949€ in inventory costs (26%). Regarding the others “Italy

⁵³Consult Annex 25: Risk Analysis the entire analysis

⁵⁴Consult Annex 26: Contingency Plan detailed

⁵⁵Consult Annex 27: The Implementation Plan (Gantt-chart) of the maritime transportation project

and Croatia routes” the results are not positive however the values used in the analysis of transportation costs don’t represent negotiated values and it is strongly possible that if VW Autoeuropa go to the market and collect several proposals from carriers the values of transportation costs (maritime and container’s truck transports) present in this work project analysis will decrease and the final result could demonstrate that by the end those routes will also generate savings in transportation costs.

This work project demonstrates also to fit perfectly in the goals and strategy of logistic department: in terms of profit, enables costs optimization (transports and inventories) through the costs reduction. In the terms of growth allows the embracement of a new business opportunity highly valuable and in terms of people it supports the continuity adoption of green practices by VW Autoeuropa, through the change for a more environmental friendly transportation mode with low CO₂ emissions.

An important recommendation for the maritime transportation adoption in future by VW Autoeuropa is the development of Iberian partnerships. It’s imperative that VW Autoeuropa create partnership with the Spanish VW factories for inbound transportation projects like in the maritime transportation. By joining forces these factories increase its bargaining power and can achieve economies of scale when transporting their parts from smaller suppliers that normally represent a high cost per volume for production companies and where there aren’t traditional transport solutions for optimization.

Another recommendation, applying the knowledge obtained with this work project, is to expand the maritime transportation opportunity to other supplier’s regions which are close to seaports since the major gains in maritime transportation occur when suppliers are located not far from load ports. Choose suppliers regions that if changed for maritime transport a major percentage of the entire route can be convert from truck transport to maritime transport (i.e. choose routes where it is possible to strongly minimize the truck utilization).

The final recommendation is related with the fact of reduce the risk associated with maritime transport and consist in choose carriers that offer a variety of complement services to the maritime transport (like containers handling and delivery at factory facilities or cargo consolidation possibility by having a consolidation center) at competitive prices, to minimize the number of intermediaries in the transportation process. Choose also the seaports available that offer higher frequency of shipments per week and the ones that offer a direct route from load port to Sines port, in order to minimize the maritime transportation risk.

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